FOA Reference Guide To Fiber Optic Testing

Answers to Chapter Questions

The purpose of this book is to provide a reference guide to those involved with the testing of fiber optic cable plants and networks or those teaching the personnel who will do this work. This book is also the reference guide for FOA CFOS/T Design Specialist certification.

Many in the fiber optic industry say that fiber optic testing is the biggest problem faced by manufacturers, installers and network operators. The FOA agrees with this assessment since testing questions are the most often missed questions on FOA certification tests.

Testing is needed to verify components and the quality of installations. Testing is needed to troubleshoot networks. The whole of fiber optics depends on testing, yet it seems to be the least understood topic. This book has been written to provide a reference guide to fiber optic testing that will be understandable and provide a definitive reference to the industry.

It is assumed that the reader is familiar with basic fiber optic technology used for premises and outside plant networks at the level of an FOA CFOT. If not, you should begin by studying general fiber optics using Chapter 2 - Jargon in this book, the other FOA textbooks, FOA Online Guide (www.foaguide.org) or take the Basic Fiber Optics self-study course at Fiber U (www.fiberu.org).

Chapter 1 Quiz

1. Most of the problems with fiber optics are caused by _____.
   A. Bad fibers
   B. Poor splices
   C. Bad or dirty connectors
   D. Transmission equipment

2. To test the fiber optic cable plant in a manner in similar to how transmission equipment uses the fiber, you need a _____.
   A. Visual inspection microscope
   B. Test source and power meter
   C. OTDR
   D. Visual fault locator

3. What instrument takes a snapshot of the fiber in a fiber optic cable plant?
   A. Visual inspection microscope
   B. Visual fault locator
   C. Test source and power meter
   D. OTDR

4. When testing a fiber optic transmission system, you should first test _____.
   A. Cable plant loss
   B. Transmitter power
   C. Receiver power
   D. Connector and splice loss

5. The majority of fiber optic standards cover _____.
   A. Component specifications
   B. System specifications
   C. Testing
   D. Troubleshooting

Chapter 2 Quiz

True/False
Indicate whether the statement is true or false.

1. Optical fibers can transmit either voice, data or video using either analog or digital signals.
   True
   False

2. Singlemode fiber has a smaller core than multimode fiber.
   True
   False

Multiple Choice
Identify the choice that best completes the statement or answers the question.

3. In an optical fiber, the light is transmitted through the _____.
   A. Core
   B. Cladding
   C. Buffer
   D. Jacket

4. The diameter of an optical fiber is traditionally measured in _____.
   A. Meters
   B. Millimeters
   C. Microns (micrometers)
   D. Nanometers

5. Rays of light transmitted in multimode fiber are called _____.
   A. Reflections
   B. Refractions
   C. Waves
   D. Modes

6. Loss of a fiber or any fiber in a cable is measured in _____.
   A. dB
   B. dBm
   C. milliwatts

7. 10 dB corresponds to a factor of _____ in power.
   A. 2
   B. 5
   C. 10
   D. 100

8. A fiber stripper removes the _____ of the fiber.
   A. Core
   B. Cladding
   C. Buffer coating

9. The _____ protects the fiber from environmental harm.
   A. Primary buffer coating
   B. Aramid fiber strength members
   C. Jacket
   D. All of the above

10. Which fiber optic test instrument uses backscattered light for measurements?
   A. OLTS
   B. OTDR
   C. VFL
   D. Tracer

11. The wavelength of light used for most fiber optic systems is in the _____region and _____ to the human eye.
   A. ultraviolet, invisible
   B. solar, visible
   C. infrared, invisible

Chapter 3 Quiz

1. Cabling standards are generally written *by* _____.
   A. Manufacturers
   B. Contractors
   C. Installers
   D. Users

2. Cabling standards are generally written *for* _____.
   A. Manufacturers
   B. Contractors
   C. Installers
   D. Users

3. The best and most current source of information on standards is generally _____.
   A. Component manufacturers
   B. Reading the standards themselves
   C. TIA
   D. ISO

5. Testing a cable plant and “certifying” it per the standards means the cable plant_____.
   A. Is tested under network operating conditions
   B. Meets the minimal specifications required by the standards

C. Exceeds the performance requirements of the standards by a large margin
D. Tests better than the loss budget calculated for it during the design stage

Chapter 4 Quiz

Dirt and contamination is the most common problem encountered in fiber optics.

True
False

To effectively inspect a fiber optic connector, a microscope must be at least 400 power.

True
False

For multimode fiber testing, the launch cable will generally use some form of modal control, usually a mandrel wrap, according to test standards.

True
False

OTDR testing will generally not give the same test results as a light source and power meter.

True
False

What fiber optic instrument creates a "snapshot" of the fiber under test?

A. Inspection microscope
B. OLTS
C. OTDR
D. Visual fault locator

Microscope inspection of the connector ferrule allows one to find_____.

A. Scratches in the fiber
B. Cracks in the fiber
C. Dirt or contamination on the end of the ferrule
D. All of the above

Visual fault locators with a laser source can trace OSP singlemode fibers for lengths of _____ km.

A. 0.5-1
B. 2-5
C. 5-20
D. 20-100

Insertion loss testing is done with a _____.

A. Light source and power meter

B. Light source and power meter and reference test cables
C. OTDR with a launch reference cable
D. OTDR with two reference test cables

In order to measure the loss of the connector on the far end of a fiber with an OTDR, you must _____.
A. Attach a reference cable to the far end of the fiber being tested
B. Test a second time with the OTDR at the far end of the cable
C. Either A or B
D. None of the above, the OTDR can not make that measurement

Reference test cables for either insertion loss or OTDR testing must _____.
A. Have the same fiber type as the cable plant being tested
B. Have connectors that can be mated to those on the cable plant
C. Have connectors in good condition
D. All of the above

The reference cables you need for testing _____.
A. Can be any old cables in your toolkit
B. Should be random patch cables used for connecting equipment to the cable plant
C. Should be known good cables regularly tested for low loss
D. Must be special reference-grade test cables which can only be purchased from the test equipment manufacturer.

Chapter 5 Quiz

1. Problems with fiber optic connectors in systems are usually caused by dirty or contaminated connectors.
True
False

2. Dust caps used to protect fiber optic connectors are often dusty, so connectors must be cleaned after the dust cap is removed.
True
False

3. Visual inspection of fiber optic connectors is generally done with _____.
A. Your naked eye
B. A jeweler's loupe
C. An optical microscope
D. An electron microscope

4. Typical magnification used to inspect connectors is _____.
A. 10-100X

B. 100-400X
C. 400-1000X
D. Magnification doesn't matter

5. Visual inspection of the connector endface with a microscope is used to find_____.
A. Poor polish or scratches on the ferrule endface
B. Dirt
C. Contamination
D. All of the above

6. Always clean fiber optic connectors _____.
A. Before connecting patchcords to equipment
B. Before connecting patchcords to patch panels
C. Before connecting patchcords to test equipment
D. All of the above

7. Fiber optic connectors should be cleaned with _____.
A. Special fiber cleaners or lint free wipes with pure isopropyl alcohol
B. Cotton pads and distilled water
C. Canned air and tissues
D. A wipe on your shirt

8. The best way to clean connectors is the _____ method.
A. Wet
B. Dry
C. Wet to dry
D. Canned air

9. When inspecting connectors in an operational fiber optic network, it is important to _____ before inspecting a connector.
A. Check for power in the fiber with a power meter
B. Clean your microscope objective
C. Have cleaning supplies ready to use
D. Find a dust cap to put on the connector

10. International standards call for inspecting the _____ of the connector.
A. Area just around the fiber itself
B. The entire ferrule end
C. The ferrule end and sides
D. The entire connector

11. The proper process for preparing connectors for connection to another connector or an active device is _____ before connecting.
A. Clean
B. Inspect then clean

C. Inspect, clean and inspect again
D. Inspect, clean and inspect again until the connector is perfectly clean

Chapter 6 Quiz

1. A loss budget is the calculated loss of the cable plant while a power budget is the optical loss tolerable to a communications system.
True
False

2. Loss budgets are used to ensure _____.
A. The network design will work with the chosen communications equipment
B. Losses of components chosen are appropriate for the cable plant
C. The cable plant tests have a comparison for pass/fail decisions
D. All of the above.

3. When calculating the loss budget of a cable plant, you total the losses of all the _____ in the link.
A. Fiber attenuation
B. Connections
C. Splices
D. Passive devices
E. All of the above

4. When calculating the loss budget, you should choose the component losses using _____.
A. Loss values from industry standards that are always worst case
B. Typical losses that are generally lower than standards
C. Either typical or standard losses as long as it's documented in the design
D. Lowest possible losses so the cable plant loss budget looks better

5. You calculate the contribution of the loss of the fiber to the loss budget by _____.
A. Looking up the attenuation of the fiber on a manufacturer's data sheet
B. Dividing the length of the fiber by the attenuation
C. Multiplying the length of the fiber by the attenuation coefficient
D. Choosing the best loss possible

6. When calculating the contribution of the fiber loss to the loss budget, you must consider the _____ .
A. Size of the fiber
B. Type of cable
C. Termination of the fiber

D. Wavelength of the light in the fiber

7. Connector losses are calculated by adding up all the losses of the connectors, always _____.

A. Including the connectors on each end of the cable plant
B. Including the connectors on each end of the cable plant only if they are connected to a patchcord
C. Excluding the connectors on each end of the cable plant
D. Excluding the connectors on each end of the cable plant if the cable is connected directly to a transceiver

8. A premises cabling link 100 meters long uses multimode fiber (3.0 dB/km @ 850nm) and two connections in the middle as well as two connectors on the ends (0.50 dB/connector). The calculated loss budget would be _____.

A. 1.30dB
B. 2.30dB
C. 3.30dB
D. 5 dB

9. Recalculate the loss budget of the premises cabling link above (100m with 2 connections and connectors on each end) using TIA 568 worst case component losses (fiber at 3.5dB/km and connections at 0.75dB). Then the loss budget now becomes _____.

A. 1.35dB
B. 1.85dB
C. 3.35dB
D. 6.50dB

10. When comparing calculated loss budgets to test values of the installed cable plant in the field to determine whether an installation is acceptable, it's important to remember _____.

A. The loss budget is an estimate
B. The test results have some errors
C. The operator must use judgment when the loss measured is close to the loss budget
D. All of the above

Chapter 7 Quiz

1. Optical power is the equivalent to _____ in electrical systems.

A. Voltage
B. Current
C. Resistance
D. Impedance

2. Optical power is physically defined in units of watts but is usually measured in a logarithmic scale and expressed in _____.

A. Milliwatts
B. Microwatts
C. dB
D. Ohms

3. A measurement in dB is a relative power measurement, for example when testing _____.

A. Transmitter power
B. Receiver power
C. Cable plant loss
D. Bandwidth

4. A measurement in dBm is an absolute power measurement, for example when measuring _____.

A. Transmitter or receiver power
B. Connector loss
C. Cable plant loss
D. Bandwidth

5. The “m” in dBm means the optical power is _____.

A. Measured by a “meter”
B. Referenced to another “measurement”
C. Referenced to “1 milliwatt”
D. A “mandatory” measurement

6. The difference between two measurements in dBm is expressed in dB, for example in measuring loss.

True
False

7. A 3 dB loss in the cable plant means the optical power has changed by a factor of _____, while 10 dB is a factor of _____.

A. 2, 10
B. 2, 100
C. 20, 1000
D. 10, 100

8. Fiber Optic power meters are calibrated at different wavelengths because the sensitivity of their detectors varies with wavelength.

True
False

9. OTDRs measure optical power on the vertical scale and _____ on the horizontal scale of a fiber trace.

A. Pulse width
B. Distance
C. Resolution
D. Reflectance

10. The attenuation coefficient of a fiber as measured by an OTDR is calculated in _____.
A. dB
B. dBm
C. dB/km
D. dBx

Chapter 8 Quiz

1. Cables tested with an OTDR do not require insertion loss testing with a source and meter or OLTS.
True
False

2. OTDR testing will generally give the same test results as insertion loss testing with a light source and power meter.
True
False

3. 5. What test instrument(s) are used for insertion loss testing?
A.OLTS or power meter and test source
B.VFL
C.OTDR

4. What is a "0 dB" reference?
A. The output of the test source
B. The connection loss of the source and launch cable
C. The power level measured during the one-, two- or three-cable reference setting process
D. What the power meter measures

5. Multimode graded-index glass fiber optic cables are tested with sources at _____ and _____ wavelengths.
A.650, 850 nm
B.850, 1300 nm
C.980, 1400 nm
D.1310, 1550 nm

6. Singlemode graded-index glass fiber optic cables are tested with sources at _____ and _____ wavelengths.
   A. 650, 850 nm
   B. 850, 1300 nm
   C. 980, 1400 nm
   D. 1310, 1550 nm

7. What type of source is used for testing singlemode fibers?
   A. LED
   B. VCSEL
   C. Laser

8. What type of source is used for testing multimode fibers?
   A. LED
   B. VCSEL
   C. Laser

9. What type of source is <u>not recommended</u> for testing multimode fibers even though it is used as a network transmitter?
   A. LED
   B. VCSEL
   C. Laser

10. How many methods are included in standards for setting the "0 dB" reference for insertion loss testing?
   A. One
   B. Two
   C. Three
   D. Four

11. Reference cables must match the _____ of the cables being tested.
   A. Fiber size and type
   B. Fiber size and connector type
   C. Connector type
   D. Fiber size and loss specification

12. The reference cables you need for testing _____.
   A. Can be any old cables in your toolkit
   B. Should be random patch cables used for connecting equipment to the cable plant
   C. Should be known good cables regularly tested for low loss
   D. Must be special reference-grade test cables purchased from the test equipment manufacturer.

13. The reference cables needed for testing insertion loss _____.
   A. Can be any old cables in your toolkit

B. Should be random patch cables used for connecting equipment to the cable plant
C. Should be known good cables regularly tested for low loss
D. Must be special reference-grade test cables purchased only from the test equipment manufacturer.

14. If a cable plant tests shows unacceptably high loss, the first thing the tech should do is _____.
A. Inspect and clean all connectors
B. Check the calibration of the test equipment
C. Test the reference cables for connector loss
D. Test again with a high resolution OTDR

15. Loss budgets are calculated by adding up _____ from the cable plant.
A. All connector losses, including the ones on the end of the cable
B. All splices
C. All fiber attenuation
D. All of the above plus any other passive devices in the cable plant

Chapter 9 Quiz

1. Length measurements by the OTDR are shorter than the actual cable because the fiber is longer than the cable itself.
True
False

2. Reflections seen in traces from OTDRs comes from mismatches in the index of refraction at a joint being tested.
True
False

3. Standards allow OTDRs to be used instead of a test source and power meter or OLTS (optical loss test set) to test a cable plant.
True
False

4. OTDR measurements are directional and traces should be taken in both directions and averaged to get reliable data.
True
False

4. “Ghosts” are caused by high reflectance events, usually connectors, in a short fiber optic cable.
True
False

6. OTDRs utilize the _____ in the fiber to make measurements.
   A. Bandwidth
   B. Backscatter
   C. Absorption
   D. Dispersion

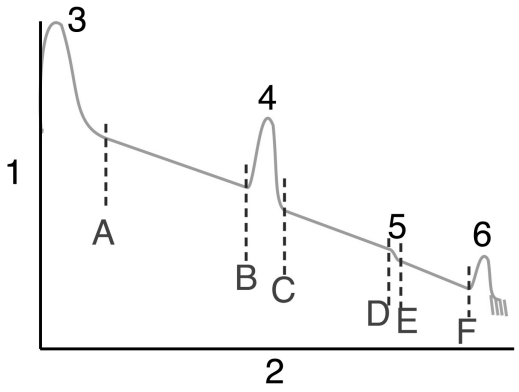
7. OTDRs measure the length of a cable. What information is needed to make this measurement accurately?
   A. Attenuation of the fiber
   B. Speed of the light in the cable
   C. Whether the fiber is multimode or singlemode
   D. Connection and splice losses

8. Length measurements by the OTDR are about _____ than the actual cable because the fiber is loosely wound in the cable for protection from tension during pulling.
   A. 1-2% longer
   B. 2-5% longer
   C. 1-2% shorter
   D. 2-5% shorter

9. To make measurements of the entire cable being tested, OTDRs must be used with _____.
   A. A launch cable to measure the connector on the near end of the cable
   B. A receive cable to measure the connector on the far end of the cable
   C. Both launch and receive cables to include connectors on both ends of the cable

10. For testing a cable, the OTDR range should be set _____.
   A. As short as possible
   B. Approximately twice the expected length of the cable
   C. As long as possible
   D. Any of the above

The following questions refer to this diagram of an OTDR trace.



11. The OTDR trace shows a graph of the data in the format shown. The vertical (Y) axis shows _____.

A. Optical power in dB
B. Optical power in dBm
C. Distance in meters, miles or kilofeet
D. Time to the events

12. The horizontal (X) axis on an OTDR trace shows _____.

A. Optical power in dB
B. Optical power in dBm
C. Distance in meters, miles or kilofeet
D. Time to the events

13. The distance from the Y axis to point A on the trace that includes event 3 shows the _____.

A. Length of the launch cable
B. Power of the OTDR test pulse
C. The dead zone of the OTDR
D. Loss in the launch cable

14. From the Y-axis to point B is the length of the _____.

A. Dead zone
B. Launch cable
C. Cable under test
D. Test pulse width

15. To measure the length of the cable under test, you need to measure the distance between points _____ and _____.

A. A and B
B. C and F
C. A and F
D. B and F

16. Event #4 is a connector since it shows _____.

A. Splice
B. Both reflectance and loss
C. Kink in the cable
D. Break in the cable

17. Event #5 shows loss but no reflectance, so it is either a _____ or a _____.

A. Fusion splice
B. Prepolished/splice connector
C. Kink in the cable
D. Break in the cable

18. Measuring from point B to point C on the trace will give the _____ at event #4.

A. The length of the connector
B. Loss of the connector
C. Reflectance of the connector
D. Dirt on the connector

19. To measure the attenuation coefficient of a segment of the cable in dB/km, you should measure between points _____ and ____.

A. A and B
B. C and D
C. E and F
D. All of the above

20. Event #6 is the connector on the end of the cable. How can you measure the loss of this connector?

A. Place a marker after the pulse and measure the loss
B. Measure the height of the reflectance pulse
C. Measure the width of the reflectance pulse
D. Add a receive cable connected to the end of the cable under test

Chapter 10 Quiz

1. Fiber characterization includes CD, PMD and SA tests in addition to the usual connector inspection, insertion loss and OTDR tests.

True
False

2. All fibers intended for use at speeds above 1Gb/s require fiber characterization.

True
False

3. Polarization mode dispersion PMD) can be affected by environmental factors like wind speed on aerial cable or vibration from railroads on buried cable.

True
False

4. PMD effects can be compensated by using special fibers near the receiver.

True
False

5. _____ needs testing on long distance fiber networks to ensure proper link performance at high speeds.

A. Chromatic dispersion
B. Polarization mode dispersion
C. Insertion loss
D. All of the above

6. The development of _____ allowed the use of CWDM (coarse wavelength division multiplexing) over the full range of singlemode fiber bands.

A. Bend-insensitive fiber
B. Multicore fiber
C. Low water peak fiber
D. Tunable lasers

7. The _____ test for CD requires access to only one end of the fiber.

A. Phase shift
B. Pulse delay
C. Aggregate
D. OTDR

8. Waveguide dispersion in singlemode optical fiber is caused by the difference in _____ of the fiber at different wavelengths.

A. Mode field diameter
B. Attenuation
C. Backscatter
D. Index of refraction

9. Material dispersion in singlemode optical fiber is caused by the difference in _____ of the fiber at different wavelengths.

A. Mode field diameter
B. Attenuation
C. Backscatter
D. Index of refraction

10. Stress on the fiber can cause variations in _____ in cabled singlemode fiber.

A. Chromatic dispersion
B. Polarization mode dispersion
C. Mode field diameter
D. Spectral attenuation

11. Fiber characterization test results should be compared to _____ to determine if the network is capable of supporting the network speeds desired.
A. Network specifications
B. Fiber specifications
C. Statistical models of the fiber optic cable plant
D. Loss budgets

Chapter 11 Quiz

Reflectance and optical return loss of a fiber joint are the same except for the polarity of the measurement.
True
False

Reflectance and optical return loss of a complete fiber cable plant are the same except for the polarity of the measurement.
True
False

Reflectance is a contributor to the loss of a fiber connection.
True
False

If a reflectance peak on an OTDR trace is flat-topped, it means you cannot measure reflectance because the OTDR receiver is saturated and the real peak is not measurable.
True
False

OCWR testing requires _____ the end of the cable properly to get more accurate results.
A. Terminating
B. Breaking
C. Polishing
D. Cleaning

OTDR reflectance measurements depend on knowing the _____ of the fiber.
A. Attenuation coefficient
B. Backscatter coefficient
C. Reflectance coefficient

D. Length

Whether it is being tested by an OCWR or an OTDR, the uncertainty of a reflectance measurement is about _____.

A. ~ 0.01 – 0.05 dB
B. ~ 0.1 – 0.2 dB
C. ~ 1 – 2 dB
D. ~ > 5 dB

Chapter 12 Quiz

1. As with any fiber optic network, testing is greatly simplified when one has proper documentation for the system.

True
False

2. The insertion loss of the link between the CO or head end where the OLT is located and the user at the ONT is measured with an optical loss test set (light source and power meter) and should be measured at all wavelengths used in the system.

True
False

3. Connector reflectance is important because of the short links in PONs.

True
False

4. When calculating a loss budget for a PON, the splitter or splitters if cascaded should not be included.

True
False

5. OLTS testing needs to be done only in either direction on a PON and at either of the wavelengths used in the PON.

True
False

6. Each factor of two split in a PON splitter adds _____ dB loss.

A. 1
B. 2
C. 3
D. 10

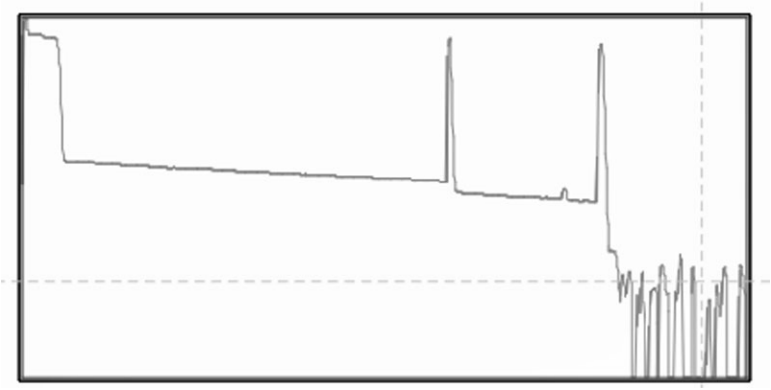
7. The differences caused by testing the PON coupler in opposite directions can

be confusing when testing with a/an _____.

A. Optical Time Domain Reflectometer (OTDR)
B. Optical Loss Test Set (OLTS)
C. Visual fault locator (VFL)
D. Optical Power Meter (OPM)

8. The OTDR trace (below) of a passive optical network is taken in the _____ direction.

A. Downstream
B. Upstream



9. In the trace above the large drop near the left side of the trace is caused by _____.

A. The loss of the OTDR connection
B. The loss of the connector on the launch cable
C. The loss of the PON splitter
D. A break in the cable

10. Two things which make testing FTTH PON networks different from other testing are _____ and _____.

A. PON splitters
B. WDM (wavelength division multiplexing)
C. Short cable runs
D. 1550 nm sources

Chapter 13 Quiz

1. The only reason to test a fiber optic cable plant is to produce a report so the customer will accept the installation and OK payment
True
False

2. Every cable plant should be tested with an OLTS and an OTDR.
True
False

3. Most fusion splicers give feedback on problems if the operator is properly trained.
True
False

4, Cable plants should be tested for insertion loss and the results compared to _____.
A. TIA standards
B. ISO/IEC standards
C. Manufacturer's specifications
D. A calculated loss budget

5. _____ in the cable plant near the source may cause nonlinearities in the laser transmitter which distort pulse shapes, causing high bit error rates (BER).
A. Kinks
B. High loss
C. Reflectance
D. Nonlinearities

6. Long cables intended for very high speed networks require fiber characterization including testing for _____ in addition to visual inspection, OTLS and OTDR testing. (check all that apply)
A. Spectral attenuation
B. Chromatic dispersion
C. Polarization mode dispersion
D. Exact fiber length

Chapter 14 Quiz

1. Scientists studying measurements at standards labs prefer the term "measurement uncertainty" to "accuracy."
True
False

2. Systematic errors mean measurements will all be in error but not all by the same amount.
True
False

3. In making fiber optic measurements, cleanliness of the connector can cause random errors.
True
False

4. The traditional mandrel wrap mode conditioner is a good approximation of the new encircled flux standard.

True
False

5. Bidirectional tests with an OTDR give the actual loss of a fiber joint, either a splice or a connection.

True
False

6. Fiber loss variations can be caused by test source wavelength and test source spectral width.

True
False

7. If a measurement had an average of -10.02 dB and as standard deviation of 0.20 dB, we could say the real measurement has a ____ likelihood of being in the range of -9.62 to -10.42 dB.

A. 33%
B. 68%
C. 95%
D. 100%

8. Which of the following can cause systematic errors in insertion loss testing?

A. Mode power distribution
B. Source wavelength
C. Dirt and contamination on connectors
D. Reference cable fiber core diameter

9. OTDRs show "gainers" because of _____.

A. Directional differences in backscatter
B. Different backscatter levels in different fibers
C. Wavelength shifts over long fiber runs
D. Pulse width variations due to fiber bandwidth

10. Encircled flux specifies that the power in the fiber is concentrated in the _____.

A. Outside of the core
B. Center of the core
C. Inner 30% of the cladding
D. Joint between two fibers

11. The test to check source mode power distribution for encircled flux is called _____.

A. EFF (EF factor)
B. CPR (Coupled Power Ratio)

C. HOML (Higher order mode loss)
D. MPD (mode power distribution)

12. Multimode insertion loss tests with a controlled mode power distribution using encircled flux with a LED source will generally result in _____.

A. Lower loss than without mode conditioning
B. Higher loss than without mode conditioning
C. About the same loss as without mode conditioning
D. Close correlation to OTDR tests